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(71) Applicant: ILLINOIS TOOL WORKS INC.
8501 West Higgins Road
Chicago Illinois 60631(US)

(72) Inventor: Barth, Gerald Dean
1135 Sunbury Road
South Elgin Illinois 60177(US)

(72) Inventor: Wagner, David Prugh
6 North Andover Lane
Geneva Illinois 60134(US)

(74) Representative: Rackham, Stephen Neil et al,
GILL JENNINGS & EVERY 53-64 Chancery Lane
London WC2A 1HN(GB)

(54) **A screw-threaded fastener.**

(57) A screw 10 for soft material 20 has an asymmetrical thread form 16, 18 which includes an upper flank 28 comprised of a plurality of continuous helical surfaces 34, 36 or 34, 35, 36. The upper flank surfaces are shaped so that a helical protrusion 36 is formed on the upper flank 28 which increases friction between the screw 10 and the material 20 only after the screw's head 12 has seated on a workpiece 24 and the soft material 20 is deformed.

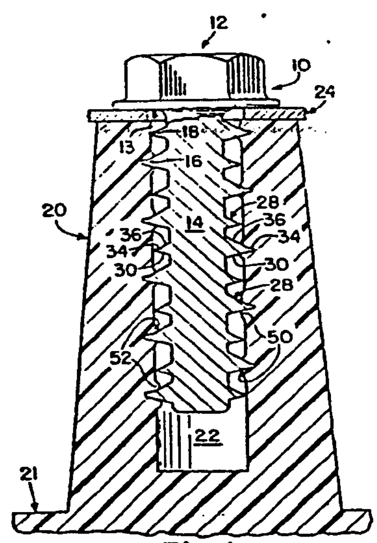

Fig. 1

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Croydon Printing Company Ltd.

0133773

Illinois Tool Works Inc.

80/2281/02

A Screw-threaded Fastener

The present invention relates to screw-threaded fasteners for use in soft material such as plastics. The invention also has application in other material such as cast aluminium. Screw-threaded fasteners for such soft materials typically comprise a head, a shank having an entering portion at the opposite end to the head, and at least one thread on the shank.

Fastening to such a material has been a problem particularly when a boss is formed in the workpiece to conserve material, to provide spacing, or to provide more material for engagement. Bosses tend to break as a result of radial stresses induced in them upon insertion of a screw-threaded fastener. Frequently, when bosses are used, the boss location is the only suitable place for fastening and thus, if the boss is damaged, no alternative exists but to discard the entire part.

Another problem associated with fastening to soft material is due to the fact that screws are often driven with mechanical drivers having settable torque limiting clutches. The use of such drivers makes it desirable to design screws with a large operating range (O.R.). The O.R. is the difference between the maximum amount of torque required to drive a screw and the minimum torque at which a screw strips out. If a screw has a small O.R., variations (even within allowable tolerances) in hole size, screw size and finish, make proper setting of an automatic clutch difficult, because those variations tend to make some screws undrivable and others strip out. Screws having a large O.R. make an effective setting of the clutch easier, because tolerance variations in the screw or workpiece less often result in a screw falling

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outside the O.R. Th result is that few r scr ws are undrivable, f w r screws strip, and fewer parts need to be scrapped.

According to this invention, such a screw-threaded fastener has a thread including an upper and a lower flank, with the upper flank having a compound surface larger in area than the lower flank, so that the thread has an asymmetrical transverse cross-section which increases surface friction between the upper flank and material into which the fastener is inserted and which is deformed upon further tightening of the fastener after contact between the head and a workpiece.

The present invention provides a screw-threaded fastener having a thread which increases stripping torque without significant increasing the radial stress in a boss. It also provides a screw-threaded fastener which increases stripping torque without a proportionate increase in the driving torque. Another advantage is that a fastener is provided which optimizes the use of blank material to permit a larger shank diameter with a particular crest diameter.

Particular examples of screw-threaded fasteners in accordance with this invention will now be described with reference to the accompanying drawings; in which:-

Figure 1 is a longitudinal sectional elevation of a fastener in use;

Figure 2 is an enlarged sectional elevation of a portion of a fastener having an alternative thread form;

Figure 3 is an enlarged semi-diagrammatic view illustrating the interaction of the fastener with various hole sizes;

Figure 4 is an enlarged sectional elevation of a further thread form; and,

Figures 5 and 6 are enlarged sectional el vations of the first example of thread form before and after tightening, respectively.

In Figure 1, a screw 10 is shown inserted in a bore 22 formed in a boss 20 projecting from a workpiece 21. The screw 10 has a hexagonal head 12 with an undersurface 13. It should be noted that any of several other head configurations may be used, such as recessed, oval head, Phillips, slotted, etc. The screw has a double lead thread form on an elongated shank 14 including a high thread 16 and a low thread 18. The screw 10 is shown clamping an article 24 to the upper surface of the boss 20. The high and low threads 16 and 18 have generally similar shapes with the high thread 16 being substantially larger than the low thread 18. Each thread is comprised of an upper flank 28 on the head side of the thread and a lower flank 30 on the side of the thread facing the entering end of the screw. The lower flank 30 is generally straight in cross-section while the upper flank 28 is compound and includes an inner surface 36 and an outer surface 34. The thread form shown in Figures 3, 5, and 6 is the same as that shown in Figure 1.

Figure 2 is an alternative thread form in which the upper flank is like that of Figures 1, 3, 5 and 6 except that the inner surface is further compounded and includes a second inner surface 35. In Figure 2, the lower flank 30 makes an angle A with a plane 40 perpendicular to the axis of the screw 10, which angle A is approximately 15°. The angle B between the outer surface 34 and the lower flank is approximately 30°. The inner surface 36 makes an angle C of about 60° with the lower flank 30. The second inner surface 35 is 60° with the lower flank 30. The second inner surface 35 is generally parallel to the outer surface 34.

The lengths of the surfaces are such that the screw works optimally in various materials. The outer surface 34 intersects the inner surface 36 at a distance approximately equal to 75% of the height of the thread. The height is defined as the radial distance between the crest surface 32 and the root surface 38. This is true with respect to all of the embodiments shown in the Figures. The intersection of the inner and outer surfaces 36 and 34 at the above described distance is intended to facilitate insertion of the screw in harder, more brittle plastics and soft metals. The relatively shallow 30° included angle B at the tip 26 of the thread has been found to be successful in providing low drive torque and yet providing sufficient strength to attain adequate pull-out values, while also generating tolerable radial stresses.

Figure 4 shows a third embodiment of the present invention. The upper flank of this embodiment includes outer and second inner surfaces 34 and 35 substantially similar to that of the embodiment of Figure 2. However, the inner surface 36' is curved. Another distinction between the embodiment of Figure 4 and the others is that it has only a single thread height. It should be noted however, that this and the other embodiments could include either single or double lead thread designs.

Figure 3 shows, in diagrammatic form, approximate hole sizes for materials of various hardnesses. The hole sizes are shown intersecting the threads at various locations. The designations H, M, and S stand for "hard", "medium", and "soft" respectively. Harder and more brittle materials should engage the high thread 16 at approximately the intersection between the outer surface 34 and the inner surface 36, and the harder brittle material should only abut the crest surface 32 of the low thread 18. Materials of intermediate softness

and toughness should engage at approximately the intersection of th inner and outer surfaces of the low thread 18. Soft plastic material should engage substantial portions of both threads. Such materials can withstand large localized deformations without translating such deformations into large radial stresses. It should be noted that the above discussion is meant to be a general guideline. Thermoset plastic materials such as phenolics and glass filled polyesters generally require large holes to avoid breaking during driving. Thermoplastics such as ABS, and polyethylene can be formed with smaller holes.

Figures 5 and 6 show enlarged views of localized deformations of workpiece material upon the insertion of a screw in accordance with the present invention. Figure 5 shows small deformations 52 and 50 adjacent the tip 26 of the high thread 16 as the screw is being threaded into a workpiece. As the head of the screw (not shown) comes into contact with the workpiece, further axial movement of the screw is prevented. Figure 6 shows the augering or Archimedean effect upon the workpiece after an approximately 90° rotation (1/4 turn) of the screw after the head contacts the workpiece. The dotted line 60 in Figure 6 shows the initial position of the screw at the instant the head contacts the workpiece, while the solid profile 62 represents the final position of the screw after 1/4 turn from the position represented by line 60. The rotation of the screw from initial position to a 1/4 turn position creates an enlarged deformation 56 adjacent to the upper flank 28 of the high thread 16. Because the upper flank of the thread is enlarged, increased frictional resistance to rotation begins to take effect upon tightening of the screw. In softer workpieces, the low thread 18 will engage and deform the workpiece in a similar manner, and will form enlarged deformations (not

shown) similar to deformations 56 formed by the high thread 16.

Creations of the deformations 56 in the workpiece not only have the effect of increasing frictional resistance; the increased deformation of the workpiece as a result of the helical protrusion on the upper flank has the effect of work hardening (strain hardening) areas of the workpiece adjacent to the upper flank. The effects of work hardening are most notable in thermoplastic materials where soft materials can become significantly stronger and harder as a result of plastic deformation. This increased strength and hardness contributes to the screw's ability to resist stripping and pull-out.

Each of the upper flank surfaces are generally smooth so that the screw can be easily inserted. By making the upper flank surfaces smooth and without surface interruptions a screw will be capable of improved performance in a variety of materials and hole sizes. However, it should be noted that in some situations, surface interruptions on the inner surfaces of the upper flank could be advantageous, either to prevent stripping or to prevent loosening of the screw.

By creating a compound surface and continuous helical protrusion only on the upper flank, more metal can be left in the blank to increase resistance to torsional failure. Therefore, for a given crest diameter, a screw of the present invention, having an asymmetrical profile, will have a larger root diameter than a screw having a similar protruding upper as well as lower flank, if made from the same sized blank material.

CLAIMS

1. A screw-threaded fastener (10) comprising a head (12), a shank having an entering portion at the opposite end to the head (12), and at least one thread on the shank (14), characterised in that the thread includes an upper (28) and a lower (30) flank, with the upper flank (28) having a compound surface larger in area than the lower flank (30), so that the thread (16, 18) has an asymmetrical transverse cross-section which increases surface friction between the upper flank (28) and material (20) into which the fastener (10) is inserted and which is deformed upon further tightening of the fastener (10) after contact between the head (12) and a workpiece (24).

2. A screw-threaded fastener according to claim 1, wherein the compound surface comprises two generally smooth helical surfaces (34, 36), the outer surface (34) lying at an angle with respect to the inner surface (36).

3. A screw-threaded fastener according to claim 2, wherein the inner (36) and the outer (34) surfaces of the upper flank (28) intersect at a distance from the base of the thread (16, 18) approximately equal to 75% of the height of the thread (16, 18).

4. A screw-threaded fastener according to claim 1, 2 or 3, having a plurality of substantially similarly shaped threads (16, 18).

5. A screw-threaded fastener according to claim 4, wherein one of the threads (16) is larger than an other of the threads (18).

6. A screw-threaded fastener according to claim 5 wherein the other of the threads (18) is approximately two-thirds as high as the one of the threads (16).

7. A screw-threaded fastener according to claim 4, 5 or 6, wherein the threads (16, 18) are spaced from one

another by an average amount approximately equal to the average base width of the threads (16, 18).

8. A screw-threaded fastener according to any one of claims 2 to 7, wherein the inner surface (36) extends from the base of the thread (16, 18) to the outer surface (34).

9. A screw-threaded fastener according to any one of claims 2 to 7, wherein the compound surface includes a third surface (35) adjacent the base of the thread (16, 18), the third surface (35) being substantially parallel to the outer surface (34) and intersecting the inner surface (36) at a distance from the base of the thread substantially equal to 45% of the height of the thread (16, 18).

10. A screw-threaded fastener according to any one of claims 2 to 9, wherein the outer surface (34) makes an approximately 30° angle with the lower flank (30), and the inner surface (36) makes an approximately 60° angle with the lower flank (30).

11. A screw-threaded fastener according to claim 10, wherein the lower flank (30) makes an angle of approximately 15° with a plane normal to the axis of the fastener (10).

12. A screw-threaded fastener according to any one of claims 2 to 11, wherein at least one (36c) of the helical surfaces (34, 35, 36) forms a curved intersection with a plane containing the axis of the shank (14).

13. A screw-threaded fastener (10) for use in a deformable material (20) comprising a shank (14) having an enlarged head (12) at one end and an entering portion at the other end, a thread (16, 18) on the shank (14) having a lower (30) and an upper (28) flank, continuous helical protrusion means (36) carried by the upper flank (28) for frictionally engaging portions of the material (20) which are deformed as the fastener (10) is

tightened, and thereby increase the torque required to strip and remove the fastener (10).

14. A screw-threaded fastener according to any one of the preceding claims, wherein the upper flank (28) comprises two helical surfaces, an outer one (34) being generally smooth, and an inner one (36) having surface interruptions to increase engagement between the material (20) and the upper flank (28).

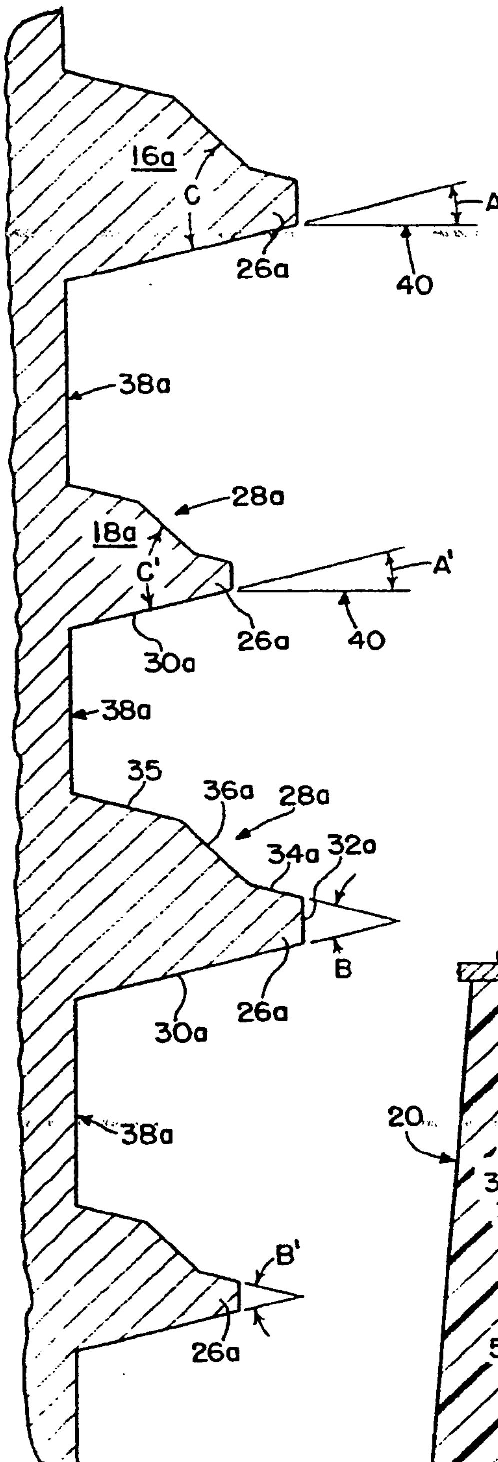

Fig. 2

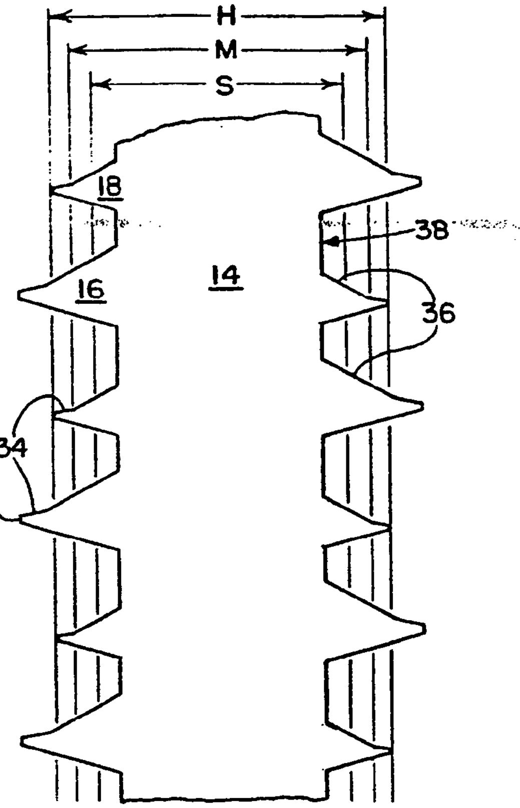

Fig. 3

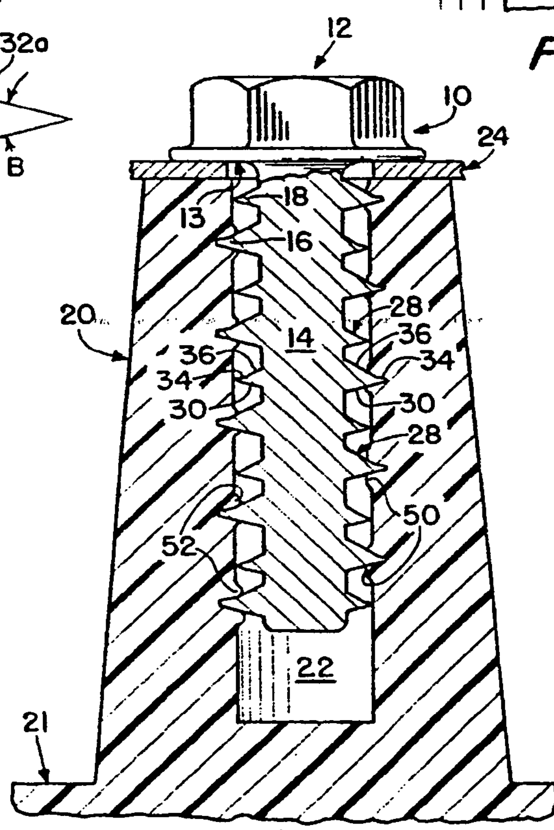

Fig. 1

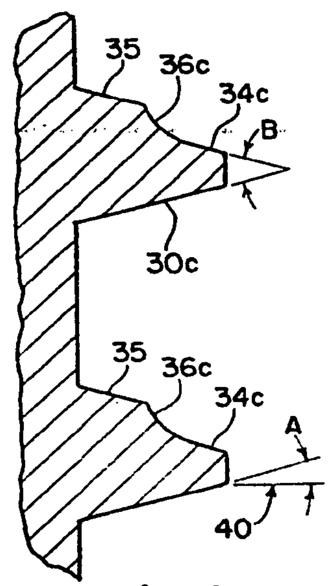

Fig. 4

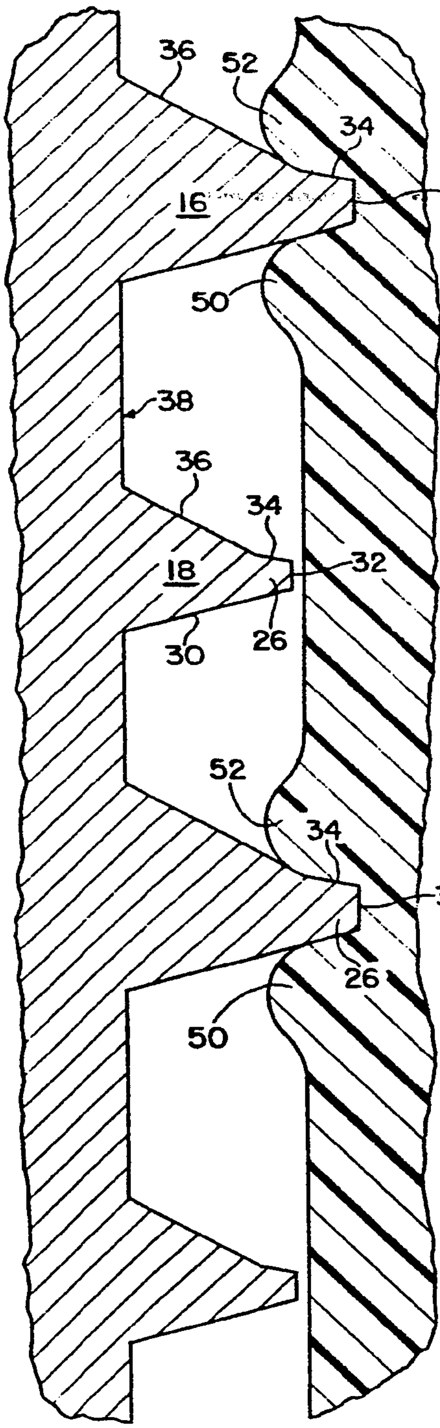
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Fig. 5

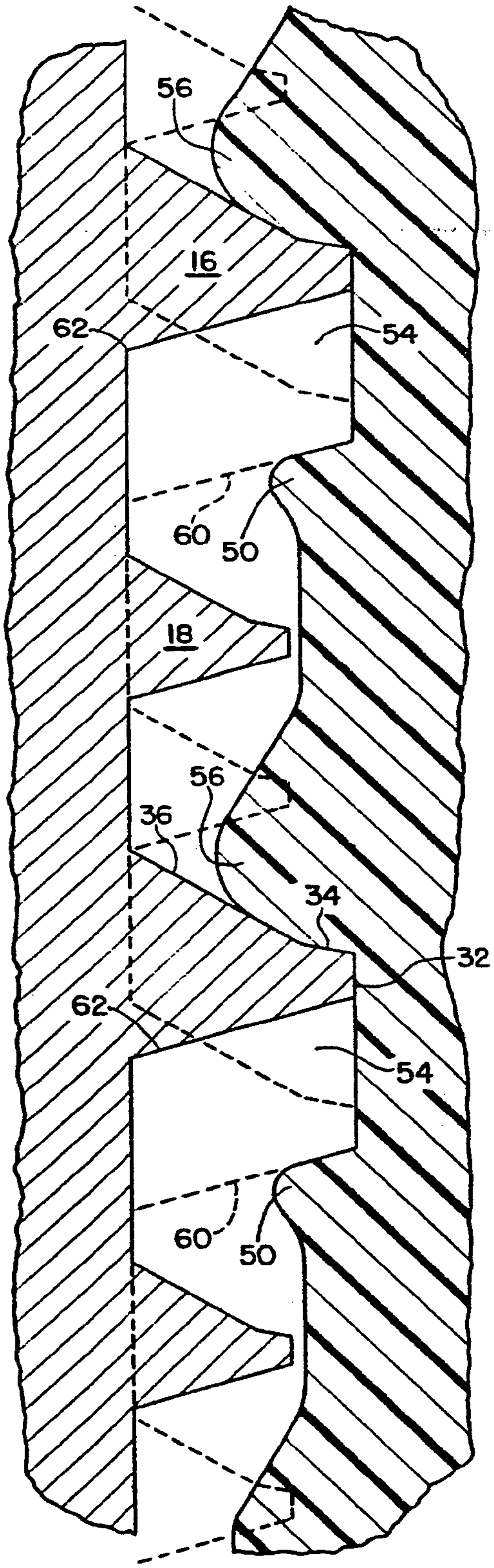
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Fig. 6

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EUROPEAN SEARCH REPORT

0133773
Application number

EP 84305057.6

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
A	DE - A1 - 2 603 217 (MAGE MANFRED GEHRING) * Claim 4; fig. *	1	F 16 B 25/00 F 16 B 35/00
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A	DE - A1 - 2 521 555 (ILLINOIS TOOL WORKS INC.) * Fig. 3 *	1	
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A	DE - A - 2 240 528 (LUDWIG HETTICH & CO.) * Claim 1; fig. *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F 16 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	19-10-1984	REIF

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